Interface Control Document (ICD) Between the Landsat 7 Ground Station (LGS) and the Landsat 7 Processing System (LPS)

May 26, 1995

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

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Landsat 7 Ground Station (LGS)
and the
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May 26, 1995

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CHANGE STATUS LOG

DOCUMENT NO. 560-1ICD/0794

TITLE Interface Control Document (ICD) Between the Landsat 7 Ground Station (LGS) and the Landsat 7 Processing System (LPS)

CHANGE	DATE	AFFECTED PAGES	REMARKS
Signature	26 May 96	ALL	Baseline

Abstract

This Interface Control Document (ICD) presents the functional, performance, operational, and design requirements for the interface between the Landsat 7 Ground Station (LGS) and the Landsat 7 Processing System (LPS).

This document provides a current understanding of the definition of the interface between the LGS and the LPS. This interface control document has been baselined by the LPS and LGS Projects for developing and implementing the interface between the LGS and the LPS.

Keywords: Interface Control Document (ICD)
Landsat 7 Processing System (LPS)
Landsat 7 Ground Station (LGS)

Preface

This ICD is controlled jointly by the Information Processing Division (IPD) Configuration Control Board (CCB) and the Networks Division CCB and may be updated by Document Change Notice (DCN) or revision. Comments and questions regarding this ICD should be directed to:

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Glossary

Acronym List

Section 1 — Introduction

1.1 Purpose

This Interface Control Document (ICD) presents the interface requirements between the Landsat 7 Ground Station (LGS) and the Landsat 7 Processing System (LPS), both located at the EROS Data Center (EDC).

This document is an incorporated part of the LGS Functional and Performance Requirements (F&PR) and the LPS Functional and Performance Specifications (F&PS). The purpose of this document is to provide further detail regarding the requirements for the interfaces described in the LGS F&PR and the LPS F&PS.

1.2 Scope

This document provides details on the functional, performance, operational, and design requirements for the interface between LGS and the LPS. This document is intended for all parties requiring such information, including system engineers and system designers responsible for implementing the interface.

1.3 Interface Responsibilities

Interface responsibilities are defined in terms of the LPS (Code 560) and the LGS (Code 531.2**)** projects. Interface functional, performance, operational, and design requirements and parameters in this ICD are subject to the bilateral control of the Information Processing Division (IPD) (Code 560) and the Networks Division (Code 530).

Section 2 — Documentation

The following documents provide more detailed information regarding the LPS, the LGS, and the Landsat 7 system. If there are conflicts between the listed documents and the requirements of this ICD, the requirements of this ICD shall be considered to be the superseding requirements

2.1 Applicable Documents

These documents were used to derive requirements.

1. Consultative Committee for Space Data Systems (CCSDS), Recommendation for Space Data System Standards; Advanced Orbiting Systems (AOS), Networks and Data Links: Architectural Specification, Blue Book, CCSDS 701.0-B-1, Issue 1, October 1989

2. NASA GSFC/MO&DSD, Landsat 7 Processing System (LPS) Functional and Performance Specification (F&PS), Signature Copy, 560-8FPS/0194, December 1994 and DCN 01, April 7, 1995.

3. National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) Landsat 7 Detailed Mission Requirements, May 15, 1995.

4. Martin Marietta Astro Space (MMAS), Landsat 7 System Data Format Control Book (DFCB), Volume 4 - Wideband Data, 23007702, December 2, 1994

5. NASA GSFC/MO&DSD, Landsat 7 Ground System (LGS) Functional and Performance Requirement (F&PR), Review, 531-FPS-GN/Landsat 7, December 1994.

2.2 Reference Documents

These documents are used for background information.

1. GSFC/MO&DSD, Systems Management Policy, MDOD-8YMP/0485, July, 1986

2. NASA GSFC/MO&DSD, Landsat 7 Processing System (LPS) Operations Concept, Signature Copy, 560-3OCD/0194, December, 1994, and DCN 01, April 7, 1997.

3. NASA, Landsat 7 Level 1 Requirements, Draft Issue, August 8, 1994.

4. MO&DSD Mission Operations Concept Document for the Landsat 7 Ground System, June 5, 1995.

5. Consultative Committee for Space Data Systems (CCSDS), Recommendation for Space Data System Standards, Telemetry Channel Coding, Blue Book, CCSDS 101.0-B-3, May 1992.

6. Santa Barbara Research Center (SBRC), L-7 Auxiliary Electronics Module (L-7 AEM) Development Specification, 150117/B, June 1994

7. NASA GSFC/MO&DSD, Landsat 7 Ground System (LGS) Operations Concept, Pre-CCB version, 430-11-06-003-0, November 1994.

Section 3 — Interface Description

LGS and LPS are major components of the Landsat 7 system. Both the LGS and LPS are located at the EROS Data Center (EDC). Figure 3-1 provides an overview of the LGS and LPS and the wideband data transfer interface between them.

3.1 LGS Description

LGS is located, along with the Landsat 7 Processing System (LPS) and the Land Processes Distributed Active Archive Center (LP DAAC), at the EROS Data Center (EDC). LGS is responsible for acquiring the ETM+ wideband data directly from the Landsat 7 spacecraft via two of three 150 Mbps X-band downlinks, separating each X-band data into two 75 Mbps I and Q channels, and transmitting the acquired wideband data through 75 Mbps LGS output ports to the LPS. LGS receives Landsat 7 contact period schedules from the MOC and provides them to LPS. The LGS coordinates its operations with the LPS in accordance with the Landsat 7 contact period schedules for the receipt of raw wideband data by the LPS. The LPS receives all wideband data at real-time rates from the LGS. The LGS is required to receive Landsat 7 X-Band downlink data at elevation angles of 5 degrees. As a nominal, 6 contacts periods will be received on a daily basis. No single Landsat 7 spacecraft contact period is expected to exceed 14.03 minutes. The LGS is designated to support Landsat 7 mission operations on a continuous basis, seven days a week, 24 hours a day. It is expected to support Landsat 7 system operations for a minimum mission life of 5 years. The operational support capabilities provided by the LGS include verification testing of the LGS functions and interfaces, hardware and software maintenance, and operator training.

3.2 LPS Description

The LPS is responsible for receiving the I and Q wideband data, in real-time, from four output channels of the LGS and storing them in its four wideband data stores, one per each LPS string. A total of 4 LPS strings are used to receive all data from the LGS. Each LPS string processes the received wideband data at a rate equal to or greater than 7.5 Mbps rate, generates level 0R, browse, and metadata files (collectively called the LPS files), and makes them available for transfer to the LP DAAC. The LPS also provides a fifth string to be used as back up for its 4 primary strings. The LPS coordinates the receipt of ETM+ wideband data with the LGS in accordance with the Landsat 7 contact period schedules. The LGS provides these schedules to the LPS in advance of the data receive time.

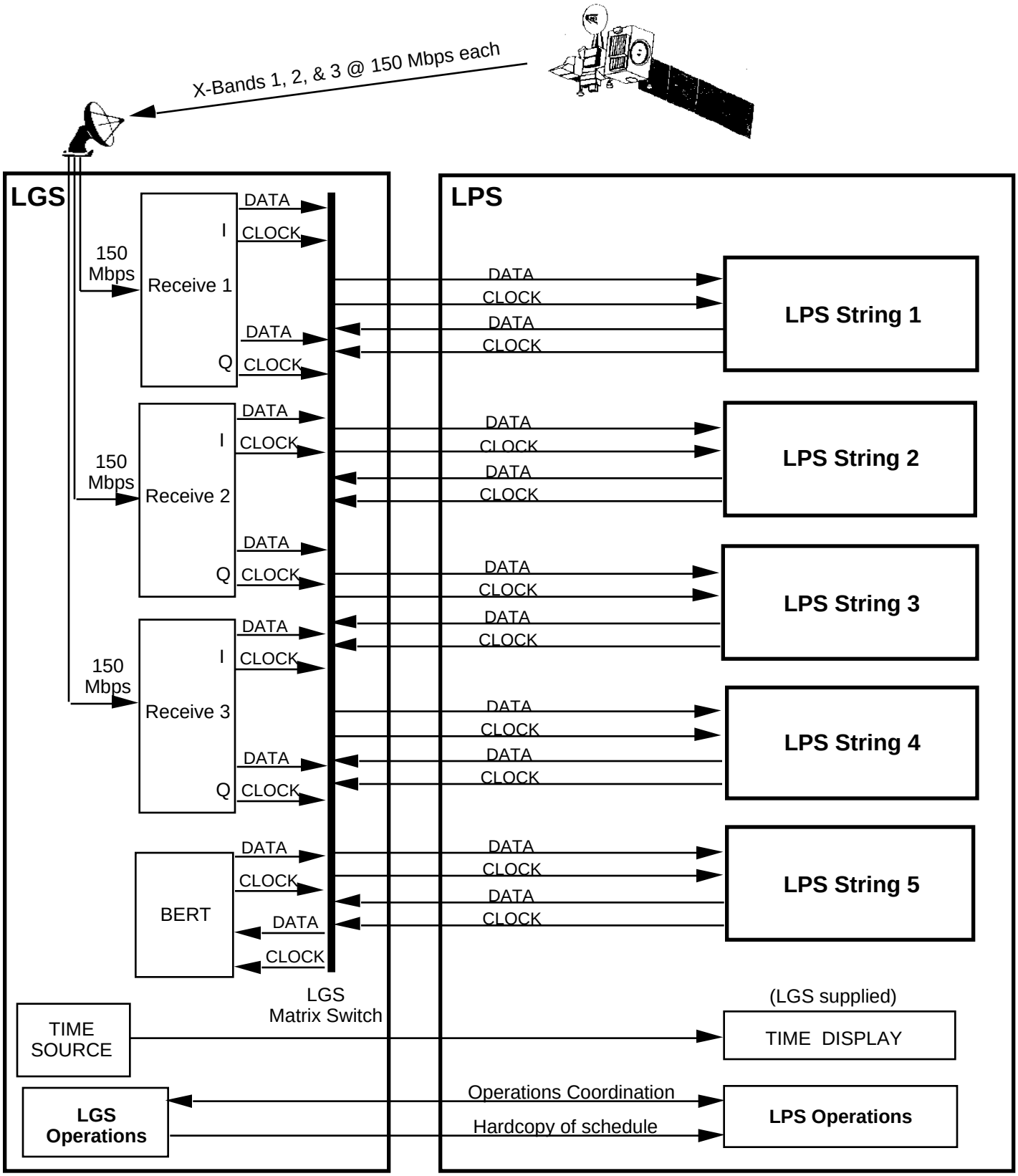


Figure 3-1: LGS/LPS Interface Block Diagram

3.3 LGS-LPS Interface Overview

The Landsat 7 ETM+ wideband data, acquired by LGS, is transmitted to the LPS over 4 (two sets of I and Q) 75 Mbps channels. LPS receives the I and Q wideband data via the four 75 Mbps LGS output channels into its four wideband data stores, one each for its four independent strings. LPS uses the Landsat 7 contact period schedule, sent to the LGS from MOC and made available to the LPS by the LGS in hard copy form, to coordinate its operations with the LGS. LPS receives all wideband data from LGS on a Landsat 7 contact period basis. Once all wideband data from a scheduled Landsat 7 contact period has been received by the four (4) LPS strings, LPS informs LGS on the completion of data receive operations by LPS (before proceeding with Level 0R processing of the received data). The LPS also provides, via voice or FAX, a data receive summary to the MOC within 5 minutes of the completion of all data receive operations for the scheduled contact period.

LPS interfaces to LGS on an LPS string to LGS output channel basis. Each LPS string is responsible for receiving the Landsat 7 data (I or Q channel) from its associated LGS output channel. The full complement of the LGS-to-LPS interface consists of 4 sets of LGS channels and 4 LPS strings. Each set is capable of transferring the LGS acquired wideband data at the real-time maximum rate of 75 Mbps. LPS also coordinates its operations with LGS to configure its fifth (spare) string with any of the five LGS output channels for back-up of either an LGS output channel or an LPS string. Each LPS string is also capable of transmitting test data either generated by the LPS string or received from the LGS bit error rate tester (BERT).

Section 4 — Interface Requirements

This section presents detailed requirements for the interface between the LGS and the LPS.

4.1 LGS Interface Requirements

4.1.1 LGS Interface Functional Requirements

4.1.1.1 LGS shall provide the capability to transmit downlink wideband data in real time to LPS on a Landsat 7 contact period basis.

4.1.1.2 LGS shall provide the capability to transmit downlink wideband data to LPS via 5 LGS output channels. Each channel contains a serial data and clock pair.

4.1.1.3 LGS shall provide the capability to simultaneously transmit downlink wideband data via any 4 of the 5 LGS output channels.

4.1.1.4 LGS shall provide the capability to simultaneously transmit the downlink wideband data associated with a single Landsat 7 X-band operational downlink, to any 2 of the 5 LGS output channels. These 2 channels contain the I and Q data streams.

4.1.1.5 LGS shall provide the capability to receive a data channel from each LPS string (one serial data and clock pair per channel) for testing purposes.

4.1.1.6 LGS shall provide the capability to transmit bit error rate tester (BERT) data to the LPS, and to receive this same BERT data from LPS, for test purposes. CCSDS format is not required for this test data.

4.1.1.7 LGS shall provide the capability to receive test data from an LPS string and to loop back this test data through the matrix switch to any LPS string.

4.1.1.8 LGS shall provide a universal time code (UTC) display, for operator usage, to LPS. The numeric display format shall be DDD:HH:MM:SS where:

DDD = day of year (001 to 365, 366 in leap year)
HH = hours (00 to 23)
MM = minutes (00 to 59)
SS = seconds (00 to 59)

4.1.2 LGS Interface Operational Requirements

4.1.2.1 LGS shall provide a daily hard copy of the schedule of Landsat 7 contact periods to LPS.

4.1.2.2 LGS shall provide a schedule of Landsat 7 contact periods at least six hours in advance of the first contact. The schedule will cover a 48 hour period.

4.1.2.3 LGS shall provide a contact schedule that contains AOS, LOS, data start time, data stop time, and link (X-band link 1,2, or 3) designation. Table 4-1 shows a sample format of the contact schedule.

LANDSAT 7 CONTACT SCHEDULE (Sample Format)

CONTACT ID	AOS / LOS	DATA START / STOP	X-BAND LINK	DURATION (data start/stop)
(yy:ddd:n)	(hh:mm:ss)	(hh:mm:ss)		(mm:ss)
99:026:1	01:00:00 01:15:00	01:01:00 01:14:00	1	13:00
	01:00:00 01:15:00	01:01:00 01:10:00	2	9:00
2	02:00:00 02:15:00	02:01:00 02:14:00	1	13:00
	02:00:00 02:15:00	02:01:00 02:14:00	3	13:00
3	03:00:00 03:15:00	03:01:00 03:14:00	2	13:00
	03:00:00 03:15:00	03:01:00 03:14:00	3	13:00

Table 4-1

4.1.2.4 LGS shall provide the following default configurations according to which 2 of the 3 links are active:

a. Links 1 and 2 active: link 1 connects to LPS strings 1 and 2, link 2 to LPS strings 3 and 4.
b. Links 1 and 3 active: link 1 connects to LPS strings 1 and 2, link 3 to LPS strings 3 and 4.
c. Links 2 and 3 active: link 2 connects to LPS strings 1 and 2, link 3 to LPS strings 3 and 4.

4.1.2.5 LGS shall resolve I&Q channel ambiguity during a contact. The I&Q channel designation shall not change during a contact.

4.1.2.6 LGS shall enable and provide the serial clock signal, along with the data signal, to LPS starting at AOS and continuously maintain the clock until the LOS.

4.1.2.7 LGS shall coordinate with LPS the switch over of an LGS output channel or the switch over of an LPS string , when necessary.

4.1.2.8 LGS shall coordinate interface fault isolation and recovery with LPS, when required.

4.1.2.9 LGS shall coordinate with LPS test data flows as required.

4.1.3 LGS Interface Performance Requirements

4.1.3.1 LGS shall transmit Landsat 7 downlink wideband data at a maximum rate of 75.0 (+ 2%) Mbps from each LGS output channel.

4.1.3.2 LGS shall transmit test data at a maximum rate of 75.0 (+ 2%) Mbps from each LGS output channel.

4.1.3.3 LGS shall receive test data at a maximum rate of 75.0 (+ 2%) Mbps from LPS.

4.1.3.4 LGS shall provide the capability to transmit all the downlink wideband data for each Landsat 7 contact. Contact periods of up to 14.03 minutes are expected. The 16 day contact schedules for 0, 3, and 5 degree acquisition circles are provided in Appendix 1.

4.1.4 LGS Interface Design Requirements

4.1.4.1 LGS shall use non-return to zero-level (NRZ-L) synchronous clock and data signals for transmitting serial data to LPS. The NRZ-L signal format is shown in Figure 4-1. Data transitions occur on the rising edge of clock (A).

4.1.4.2 LGS shall receive non-return to zero-level (NRZ-L) synchronous clock and data signals from LPS.

4.1.4.3 LGS shall use differential coax ECL (F100k or equivalent) circuit configuration to transmit serial data and clock signals to LPS.

4.1.4.4 LGS shall use differential coax ECL (F100k or equivalent) circuit configuration to receive serial data and clock signals from LPS.

4.1.4.5 LGS shall terminate each serial data and clock cable at each LPS input using a UG -88 connector or equivalent.

4.1.4.6 LGS shall use RG-223 coax cable (or equivalent) to transmit or receive serial ECL data and clock signals, cables lengths shall not exceed 50.0 feet.

4.1.4.7 LGS shall provide cables that have less than 0.60 nanosecond (ns) skew between clock (A) and clock (B). See Figure 4-1.

4.1.4.8 LGS shall provide cables that have less than 0.60 ns skew between data (A) and data (B). See Figure 4-1.

4.1.4.9 LGS shall provide cables that have less than 25% of a period skew between data (A) and clock (A). This skew shall include the combined effects of prop delay, phase instability (phase jitter), etc. See to Figure 4-1.

4.1.4.10 LGS shall provide a serial clock that has a duty cycle asymmetry of less than 20 %.

4.1.4.11 LGS shall provide serial data and clock signals that meet a BER of 10^{-9} on each channel when looped back at LPS.

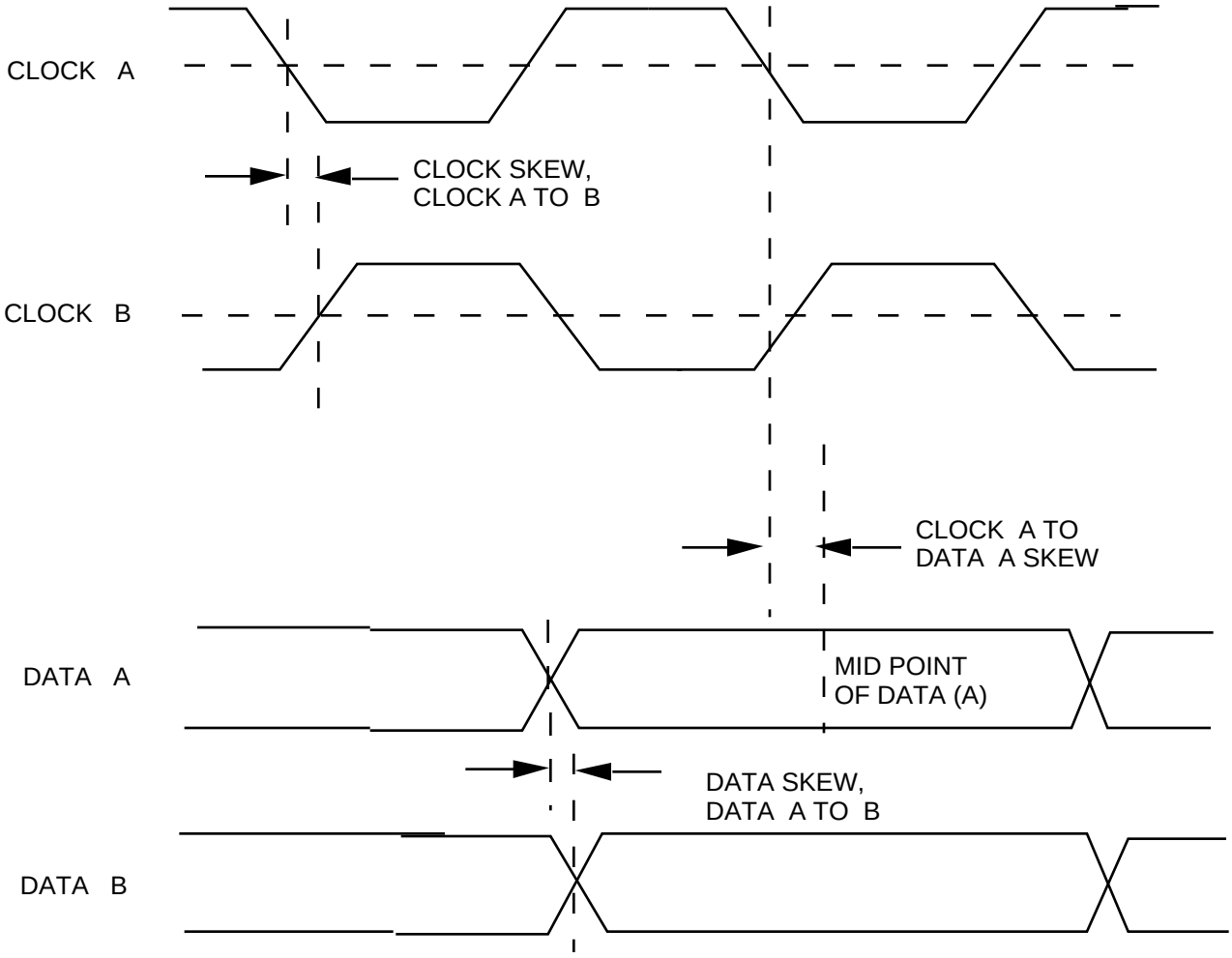


Figure 4-1

4.2 LPS Interface Requirements

4.2.1 LPS Interface Functional Requirements

4.2.1.1 LPS shall provide the capability to receive downlink wideband data in real time from LGS on a Landsat 7 contact period basis.

4.2.1.2 LPS shall provide the capability to receive downlink wideband data from LGS, via 5 LGS output channels. Each channel contains a serial data and clock pair.

4.2.1.3 LPS shall provide the capability to simultaneously receive downlink wideband data via any 4 of the 5 LGS output channels.

4.2.1.4 LPS shall provide the capability to simultaneously receive the downlink wideband data associated with a single Landsat 7 X-band operational downlink, from any 2 of the 5 LGS output channels. These 2 channels contain the I and Q data streams.

4.2.1.5 LPS shall provide the capability to transmit a test data output from each LPS string (one serial data and clock pair per channel) to LGS for testing purposes.

4.2.1.6 LPS shall provide the capability to receive bit error rate tester (BERT) data from LGS, and retransmit this same BERT data to LGS, for test purposes.

4.2.1.7 LPS shall provide the capability to transmit test data from an LPS string to LGS and to receive this test data via a loop back through the matrix switch at the LGS.

4.2.2 LPS Interface Operational Requirements

4.2.2.1 LPS shall receive a hard copy of the schedule of Landsat 7 contact periods from LGS as described in 4.1.2.1 through 4.1.2.3.

4.2.2.2 LPS shall comply with the default configuration described in 4.1.2.4.

4.2.2.3 LPS shall coordinate with LGS the switch over of an LGS output channel or the switch over of an LPS string , when necessary.

4.2.2.4 LPS shall coordinate interface fault isolation and recovery with LGS, when required.

4.2.2.5 LPS shall coordinate with LGS test data flows as required.

4.2.3 LPS Interface Performance Requirements

4.2.3.1 Each LPS string shall receive Landsat 7 downlink wideband data at a maximum rate of 75.0 (+ 2%) Mbps from an LGS output channel.

4.2.3.2 Each LPS string shall receive test data at a maximum rate of 75.0 (+ 2%) Mbps from an LGS output channel.

4.2.3.3 Each LPS string shall transmit test data at a maximum rate of 75.0 (+ 2%) Mbps to an LGS input channel.

4.2.3.4 LPS shall provide the capability to receive all the downlink wideband data from each Landsat 7 contact. Contact periods of up to 14.03 minutes are expected.

The 16 day contact schedules for 0, 3, and 5 degree acquisition circles are provided in Appendix 1.

4.2.4 LPS Interface Design Requirements

4.2.4.1 LPS shall use non-return to zero-level (NRZ-L) synchronous clock and data signals for receiving serial data from LGS. The NRZ-L signal format is shown in Figure 4-1. Data transitions occur on the rising edge of clock (A).

4.2.4.2 LPS shall use non-return to zero-level (NRZ-L) synchronous clock and data signals for transmitting serial data to LGS.

4.2.4.3 LPS shall use differential coax ECL (F100k or equivalent) circuit configuration to transmit serial data and clock signals to LGS.

4.2.4.4 LPS shall use differential coax ECL (F100k or equivalent) circuit configuration to receive serial data and clock signals from LGS.

4.2.4.5 LPS shall provide cable connections that are compatible with UG-88 connectors of the serial data and clock cables.

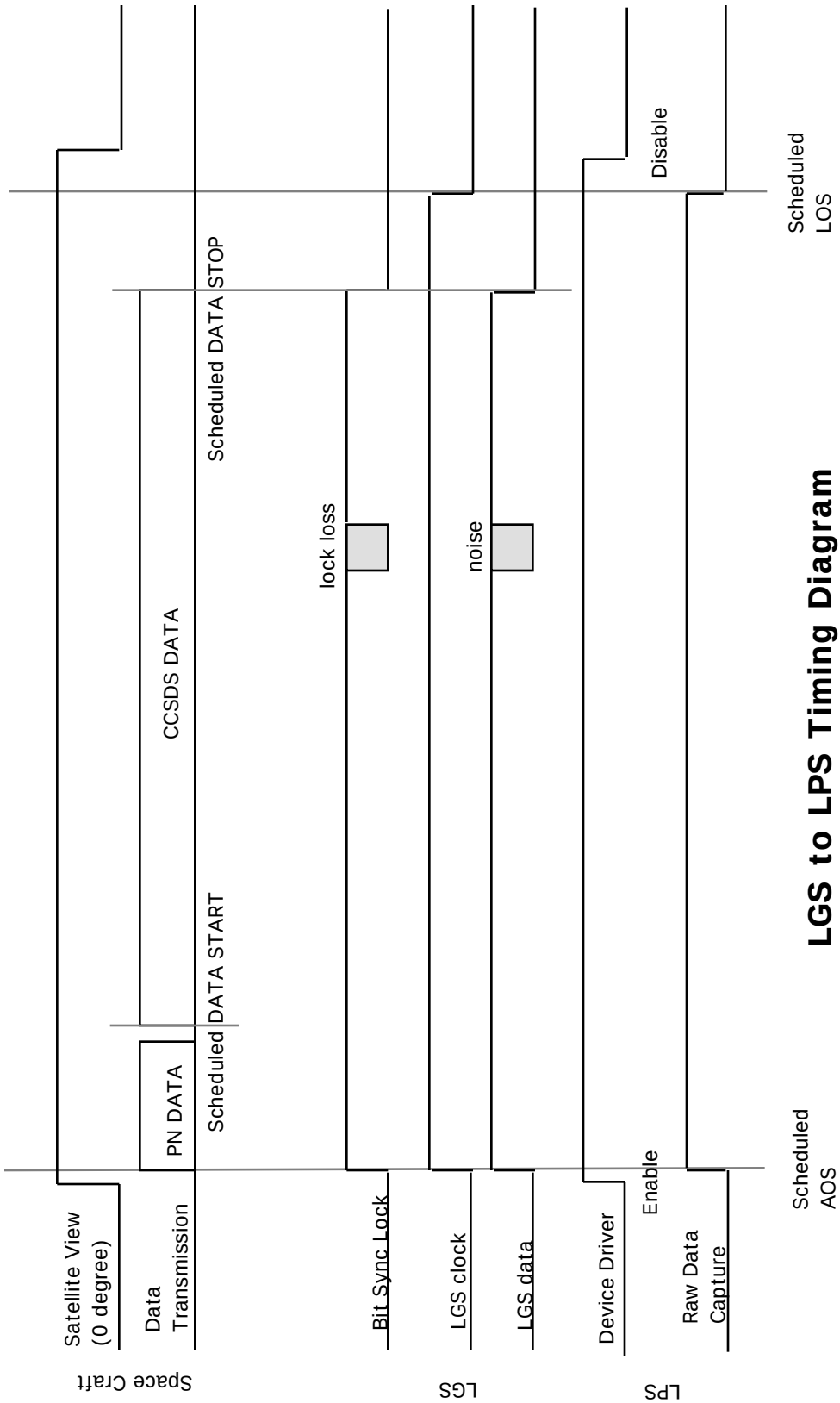
4.2.4.6 LPS shall receive a serial clock from LGS that complies with the specifications included in 4.1.4.7 through 4.1.4.11

Appendix 1

This appendix contains 0 degree, 3 degree and 5 degree acquisition circle results computed for EDC for a 16 day cycle. These results illustrate the expected durations of the contact periods received at EDC.

Appendix 2

This appendix contains a timing diagram that depicts the details on signal and data interface between LGS and LPS.



LGS to LPS Timing Diagram (playback)

Scenario

- The LPS raw data capture is enabled prior to scheduled AOS
- PN, CCSDS, and any noise is captured

Assumptions:

- LGS clock enabled at scheduled AOS and disabled at scheduled LOS
- Bit sync lock loss has no impact on clock to LPS

Glossary

Bit Error Rate (BER): The number of binary digits (bits) received in error divided by the total number of bits received over a specified time period.

Bit Error Rate Tester (BERT): Test equipment used to generate and receive test data for the purposes of measuring the BER.

Landsat 7 Contact Period: The time duration between the start and end of wideband data transmissions from the Landsat 7 spacecraft to a ground station.

LGS Output Channel: A serial clock and data pair that contains either an I or Q data stream.

LPS String: A functional entity of the LPS responsible for end-to-end processing of the raw wideband data received from a downlink channel (I or Q) of the X-band downlink data captured by the LGS.

Downlink wideband data: Mission Data originating on a spacecraft for transmission to the ground.

Acronym List

AOS	Acquisition of Signal
BER	Bit Error Rate
BERT	Bit Error Rate Tester
CCB	Configuration Control Board
CCSDS	Consultative Committee on Space Data System
DCN	Document Change Notice
ECL	emitter coupled logic
EDC	EROS Data Center
EROS	Earth Resources Observation System
ETM+	Enhanced Thematic Mapper plus
F&PS	Functional and Performance Specification
GSFC	Goddard Space Flight Center
I	in-phase signal component
ICD	Interface Control Document
IPD	Information Processing Division
LAN	Local area network
LGS	Landsat 7 Ground Station
LOS	Loss of signal
LP DAAC	Land Processes Distributed Active Archive Center
LPS	Landsat 7 Data Processing System
Mbps	megabits per second
MOC	Mission Operations Center
MO&DSD	Mission Operations and Data Systems Directorate
NASA	National Aeronautics and Space Administration
NRZ-L	non-return to zero-level
Q	quadrature signal component
UTC	Universal Time Code